



# **Smartphones Revive the Black Bag For Doctors A Mixed Blessing?**

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At one time, physicians could carry the basic tools of their profession in a black bag as they made house calls. As the technology advanced and the tools become more complex and outgrew the bag, the physician became tied to the office and clinic. Smartphones with specialized attachments and other mobile devices are becoming the new black bag. However, these smartphone apps and sensors are not just tools for the physician. The same devices are being marketed to their patients.

## Introduction

As recently as the early '60s, doctors commonly made house calls carrying a black bag with the basic tools of their profession: stethoscope, thermometer, tongue depressor, otoscope, blood pressure cuff, an assortment of bandages, needles and surgical thread, and a variety of pills. House calls gradually became the rare exception instead of the rule, and the tools of the profession expanded beyond the bag to sophisticated devices housed in labs and operated by trained specialists. These tools included ECG tests, high tech imaging exams such as ultrasound, blood and urine tests, blood oxygen saturation, and others.



All of these high tech tests were ordered by the physician, performed in the hospital or clinic, and the results were sent back to the physician as part of determining the diagnosis and care plan. This process involved several steps from the initial office visit, ordering the tests, scheduling the tests, which may or may not be done that day, getting the test results, scheduling another office visit to discuss the results and the subsequent plan with the patient. The process became another reason for the physician to stay in the office.

However, the iPhone with specialized attachments and other mobile diagnostic devices allow the diagnostic process to be streamlined and free physicians to diagnosis on the road. It has become possible to carry a black bag again, a more powerful bag. The new bag now carries an iPhone, some attachments, and small mobile diagnostic devices. Many of these devices are available now, and more are coming. Here is just a sample of what the new “black bag” may carry.

## Tricorder

There are variety of sensors available that measure various vital signs and send the readings to a smart phone for recording. One of the more intriguing is the [Scanadu Scout](#), a palm sized device that measures vital signs in 10 seconds by pressing it against a forehead. Initially it will measure temperature, heart rate, respiratory rate, and blood pressure and send the results to an app on a smart phone. More measurements are being developed, and the initial release is planned for March 2014.

### Scanadu Scout



### Kinsa Smart Thermometer



### Thermometer

Available sooner than the Scandu are a variety of sensors and apps to take and record vital signs. Temperature can be measured and recorded with the [Kinsa](#) smart thermometer, coming in November 2013. The thermometer plugs into the iPhone audio jack to power the thermometer and transmit the results to the phone. Other thermometers are in the works that employ non-contact infrared technology.

## Blood Pressure

Blood pressure and heart rate can be obtained with blood pressure cuffs, such as the [Withings BP monitor](#), that plugs into the iPhone. An app inflates the cuff, measures the blood pressure and heart rate and records the results.

### Withings Blood Pressure Monitor



**iHealth Pulse Oximeter**

### **Pulse Oximeter**

A wireless pulse oximeter is available from [iHealth Lab](#) that measures the SpO2, pulse rate, and stores the results in an app on an iPhone. iHealth also has wireless blood pressure monitors and a scale.

### **Smart Scale**

Smart scales measure weight and calculate BMI sending these measurements to an iPhone app using a Bluetooth connection. The scale from [Withings](#) is about the size of a laptop computer.



**Withings Smart Scale**



**Sanofi Glucose Monitor**

### **Blood Glucose Monitoring**

Glucose testing is a difficult issue due to the need to test glucose levels multiple times a day and keep a diary of the results, associated meal times, exercise and other variables. [Sanofi's iBGStar](#) is an iPhone attachment and app that greatly simplifies the testing and data logging process.

When plugged into the phone, the phone recognizes an inserted blood glucose strip and opens the app. After 6 seconds, the result is displayed on the screen and color coded to emphasize hyperglycemia and hypoglycemia conditions.



**Biosense Technologies Urine Analysis System**

## Urine Analysis

A urine analysis system from [Biosense Technologies](#) uses the iPhone's camera to automatically read commercial urine dipsticks using a peripheral, the cuboid and a color mat to standardize

the reading conditions. It is intended to perform analysis of 10 common analytes in urine listed on their web site. Processing takes about 30 seconds once the strip is in the mat and placed in the cube. It is available in several countries in Europe, the middle East and Asia and is awaiting FDA clearance in the U.S.

### Blood Tests

Mobile blood tests are rather limited at the moment but a [new development](#) by Sharp Laboratories of Europe promises to change that in the next few years. Microfluidics allows the development of a lab-on-chip about 4-5 cm that is a mobile lab. Results are now known in minutes instead of hours, and it requires just a drop of blood. The goal is to move this to commercialization in the next few years.

### Ear Test

In addition to vital signs apps and attachments, there are a variety of more specialized tests available with Iphone attachments. [Cellscope](#) makes a smartphone otoscope attachment that captures photos or videos of the ear. The stored images allow diagnosis, remote consultation, and tracking of changes over time. Pediatric ear infection is one common ailment that is targeted by Cellscope.

#### Cellscope Otoscope



### GE Ultrasound



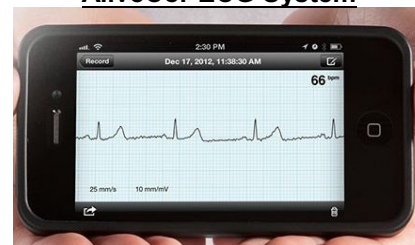
#### Ultrasound

Ultrasound exams can be done with a pocket, flip phone scanner such as the [Vscan](#) from GE Healthcare. The Vscan has the capability to provide a quick look at abdominal, urology, fetal/OB, and cardiac anatomy. This can speed diagnosis and subsequent treatment. Currently an ultrasound exam is ordered, scheduled, and performed in lab. With a hand held scanner, it can be done immediately as part of a physical exam.

### Cardiology

The cardiologist has been a big beneficiary of mobile technology with just two devices: an attachment for the iPhone to generate, display and store ECG's and mobile ultrasound devices that are more effective than just relying on the stethoscope for an initial work up. The [Alivecor Heart Monitor](#) was cleared by the FDA in November of 2012 and is now available for both the iOS and

#### AliveCor ECG System



Android smartphones. It generates a single lead ECG that can be annotated, stored, and reviewed. The device is available for physicians and can be prescribed for patients to record intermittent events and send the ECG to their cardiologist.



#### GE Cardiac Ultrasound Exam

The GE Vscan portable ultrasound also performs 2D echocardiograms including color flow for assessment of the valves, left ventricle, and pericardium. Both devices can be used in the cardiologist's office for a more complete initial assessment and anywhere else the cardiologist happens to be.

Dr. Eric Topol, chief academic officer at Scripps Health has used the AliveCor twice on airplanes. Answering the call “is there a doctor on board”, he used the AliveCor as part of his diagnosis. Once he recommended an emergency landing to get immediate treatment and the other time, an emergency landing was not necessary.

Dr. Topol no longer does a formal cardiogram. He uses his iPhone to get the ECG and if indicated, prescribes an AliveCor device for the patient to record intermittent events. He also says that he hasn't used a stethoscope for 2 years. Instead Topol pulls out his Vscan and does a full echo of the patient's heart.

### Sleep Apnea

[Watermark Medical](#) has developed a device to diagnose obstructive sleep apnea at home. The WM Sleep Portal and integrated home sleep technology replaces a more expensive overnight stay at a hospital's sleep laboratory.

#### Sleep-wearable Physiological Recorder



After vetting the candidate patient as appropriate for the study, the wearable device is either provided to the patient by their physician or is mailed directly to the patient's home. Upon completion of the study, the information is uploaded, auto-processed, undergoes a QA audit and professional interpretation by a Watermark network board certified sleep physician. The report is then sent to the ordering physician. All this is done within 48 hours.

### Eye Test

[EyeNetra](#) has under test a refraction system, Netra<sup>G</sup>, for a smartphone that will generate a prescription for eyeglasses and contact lenses. It corrects for nearsightedness, farsightedness, and astigmatism and measures the distance between the eyes.

#### EyeNetra Refraction System



The Netra is an inexpensive clip-on eyepiece that goes on top of a cell phone. The user looks through this eye piece and interactively aligns the displayed patterns by clicking the buttons. The number of clicks required to bring the patterns into alignment indicates the refractive error. The device is not available commercially yet and is currently being optimized with eye care professionals. However, its target market is the developing world where the need is great.

### Mixed Blessing

The new black bag presents problems as well as opportunities for physicians. The mobile diagnostic devices described here barely scratch the surface of what is available. The number of devices makes choosing a set for a physician's black bag an imposing task.

The number of manufacturers is almost as large as the number of devices. All of these manufacturers will have different database schema. Pulling all this disparate data into an EMR is a daunting prospect. At least one company is addressing the problem of mobile device

interoperability. [Qualcomm Life](#), a Qualcomm company, has developed a platform, 2net, which is a set of wireless health solutions.

The 2net Platform is a cloud-based system designed to be universally interoperable with different mobile medical devices and applications. Qualcomm Life says that 2net will enable end-to-end wireless connectivity and allow both device users and their physicians to easily access biometric data. The 2net solution set supports secure socket layer (SSL). It is listed as a Class I Medical Device data System in the U.S, CE listed in Europe, and Class I in Canada and is installed in several European countries.

An additional challenge for physicians and their IT departments is that almost all of the mobile health devices are not only available to patients but are being marketed to patients. Patients can show up at the office with symptoms and data to be analyzed. Getting that data from the patients smartphone into the doctor's hands and potentially the EMR, is another issue the Qualcomm Life platform may be able to solve. It will be an interesting transition for physicians when patients start arriving with their own personal medical record collected from the patients' monitoring devices and stored on their smartphones.